

Defining and measuring farmers' attitudes to farm animal welfare

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Abstract

Identifying farmers' attitudes to farm animal welfare (FAW) is an important step in determining farmers' efforts to improve FAW, knowledge of which is of particular importance for understanding how the living conditions of production animals are determined. This study developed a hypothetical model of farmers' attitudes to FAW, including the antecedents of these attitudes and possible influences on FAW-related behaviour. Two models for empirical measurement of attitudes, namely formative and reflective models, were also evaluated and compared. The results suggested that choice of measurement model considerably influences conceptualisation of attitudes and that there may be considerable model misspecifications in previous literature relating to farmers' FAW attitudes. Existing literature on farmers' FAW attitudes was reviewed with the aim of providing a preliminary indication of the coverage of farmers' FAW attitudes. A need for future research related to farmers' attitudes to FAW was identified.

Keywords: animal welfare, attitudes, factor analysis, farmers, measurement models, psychometrics

Introduction

Farm animal welfare (FAW) is defined in the literature as a human construct that is integrated into the values of humans (eg Fraser 1995; Rushen 2003). Indeed, in the study of human decision-making in relation to FAW, the standard economic welfare assumption is one of anthropocentric welfarism (McInerney 2004), whereby FAW is a subset of human welfare and the well-being of animals matters only as long as it affects the well-being of humans. This implies that improvements in FAW can be expected only when they affect the well-being of humans.

In this context, it is particularly important to understand farmers and their decision-making related to FAW, since farmers make the actual decisions about what FAW-related efforts to provide and hence ultimately determine the living conditions of farm animals. Of course, other actors, such as consumers, veterinarians and members of various pressure groups also play an important role in the debate on FAW but, as emphasised by Kauppinen *et al* (2010), farmers provide the actual care for the animals and thus play a special role.

Apart from undertaking FAW-related efforts due to national legislative requirements and/or cross-compliance in farm support schemes, farmers could be willing to provide FAW-related efforts to the extent that the utility derived from the use and non-use values (McInerney 2004) associated with these FAW-related efforts offset their associated costs. Use values refer to the productivity values associated with FAW, whereas non-use values refer

to any other value the farmer may derive from FAW (see Lagerkvist *et al* [2011] for a discussion of possible non-use values associated with FAW). Farmers, thus, face a trade-off between the utility that can be derived from FAW and the costs associated with efforts related to FAW.

In the study of human decision-making, attitudes, ie affective responses to objects (Pretty *et al* 1997; Ajzen & Fishbein 2000; Kahneman & Sudgen 2005; van Overwalle & Siebler 2005), which manifest themselves in beliefs, feelings and behaviours (eg Fazio & Olson 2003), seem important since they are one group of antecedents of human behaviour (Ajzen 1991, 2001). Understanding the general attitude farmers have to FAW would require knowledge of the domains to which the attitude corresponds, ie the coverage of the attitude, which in turn is associated with attitudes to specific parts of FAW (specific attitudes), such as hunger and thirst; comfort; pain, injury and disease; natural behaviour; and fear and distress (see the so-called Five Freedoms listed by Farm Animal Welfare Council [2009]). While there are also other antecedents of human behaviour, such as perceived control and subjective norm (Ajzen 1991, 2002), the development of valid and reliable methods to measure these specific attitudes would be one important step in understanding farmers' provision of FAW. A review of previous literature shows that several studies have examined farmers' attitudes to FAW (eg Kauppinen *et al* 2010, 2012; Kielland *et al* 2010) or adjacent attitudinal constructs. These include attitudes to

animal welfare in general (not restricted to FAW) (Austin *et al* 2005), to specific types of farm animals (Waiblinger *et al* 2002; Coleman *et al* 2003; Hemsworth 2003; Serpell 2004; Hanna *et al* 2009), to specific welfare improvement measures (eg Lech *et al* 2010; de Lauwere *et al* 2012; Tuytens *et al* 2012) and to organic farming, where FAW is one issue of significance (Lund *et al* 2004).

However, a review of the literature on farmers' FAW attitudes and related attitudinal constructs shows that there is little detail and consensus in this literature about how to conceptualise such attitudes from a theoretical point of view and about how they can be measured. This is problematic for two important reasons. First, it causes uncertainty about what has been measured in individual studies, ie we cannot know whether the same theoretical construct is being captured in all studies or whether all domains of the attitude construct are being covered. This originates from lack of a thorough and common understanding of the domains of the FAW attitude construct, and of the specific attitude constructs corresponding to each domain. It causes problems, for instance, when researchers are interested in comparing results obtained in different studies, or when researchers are seeking to build models based on previous research. As a result, researchers have to start repeatedly from the beginning, with new exploratory analyses of the FAW attitude construct. Second, the lack of theoretical specification of the FAW attitude constructs causes uncertainty when it comes to empirical strategies for measuring attitudes. For instance, how can the relationship between the attitude constructs and their empirical indicators be viewed? This leads to unnecessary ambiguity about the validity and reliability of the empirical models used for measuring theoretical attitude constructs. The measurement of attitudes has been the central interest in the field of social psychology for decades (Korsnick *et al* 2005). Successful analysis of farmers' decision-making with respect to FAW requires an in-depth understanding of such measurements and therefore would benefit greatly from being more firmly based in the practices of attitude measurement.

Given this background, the overall aim of the present study is to specify how farmers' FAW attitude may be conceptualised and measured. This was done in four steps. Firstly, we expanded a behavioural framework based on social psychology and psychometric theory to measure farmers' attitudes to animal welfare (Hansson & Lagerkvist 2012), to include farmers' FAW attitudes as an outcome of use and non-use values (McInerney 2004) and as an antecedent of farmers' behaviour with respect to FAW, and to identify the relationship between the theoretical attitude construct and its empirical indicators.

Secondly, we outlined a framework within which the so-called explicit measurements of FAW attitude constructs could be tested for reliability and validity. The main focus to date in the literature related to farmers' FAW attitudes is on the explicit measurement technique, where attitudes are elicited from answers to questions posed in questionnaires, ie existing methods for measuring attitudes can be divided into implicit and explicit techniques (eg Gawronski *et al* 2006).

The explicit technique has proven especially applicable in situations where motivation and engagement by the respondent are high (Perkins & Forehand 2011), which is most likely the case for farmers' FAW attitudes.

Thirdly, we made an empirical comparison of two different explicit measurement models in order to evaluate potential empirical problems associated with model misspecification in a dataset made available to us. From an attitude measurement perspective, there are instances of serious model misspecification at a theoretical level in the previous literature related to farmers' FAW attitudes, where a formative relationship has been assumed between the attitude construct and its indicators, although there would be stronger arguments for a reflective relationship. We examined how such model misspecification influenced our empirical understanding of the FAW attitude constructs.

Finally, we reviewed and synthesised current literature on farmers' attitudes to FAW in order to identify a preliminary empirical domain for the FAW attitude constructs. We concluded the paper by discussing the need for future research related to farmers' attitudes to FAW.

Conceptual framework

A review of the literature related to attitudes and behaviours shows consensus on viewing attitudes as one group of antecedents of behaviour (eg Ajzen 1991, 2002; Conner & Abraham 2001; Fazio & Olson 2003; Kaiser & Scheuthle 2003; Kaiser 2006; Feist 2012; Siegel Levine & Strube 2012). However, in applications building on the theory of planned behaviour (Ajzen 1991, 2002), attitudes are often viewed as being mediated through intention and as acting together with other explanatory factors, such as perceived control and subjective norm (Ajzen 1991, 2002). Nevertheless, the literature suggests that attitudes constitute one type of antecedents of behaviour. Attitude constructs would therefore be a central component in understanding farmers' efforts with respect to FAW, ie attitudes can be seen as one driving force for the decisions farmers make about animal welfare and therefore also their behaviours in this regard.

Furthermore, using arguments based on the theory of planned behaviour (Ajzen 1991, 2002), Kauppinen *et al* (2010) stressed that successful modelling of behaviour has to be based on an analysis where the attitude construct and behaviour in question are considered at the same level of abstraction. They therefore proposed a distinction between attitudes towards certain behaviours and actions and attitudes towards the phenomenon itself. In the present study we focus on attitudes to FAW itself, although the theoretical and methodological arguments put forward can easily be extended to attitudes to behaviours and actions, for instance aiming at improvements in the FAW situation.

Farmers' decisions to provide FAW-related efforts beyond the requirements imposed in national legislation and/or cross-compliance in farm support schemes depend on the extent to which they assign economic value to FAW. McInerney (2004; p 5) describes an economic value as:

a weighting that people place on something, and reflects the benefit (pleasure, satisfaction, gain, virtue, advantage) — or what economists call 'utility' — that they gain from it".

Economic value in relation to FAW may be of two types, use and non-use values (McInerney 2004). Use values refer to productivity values associated with FAW, where FAW is viewed as analogous to maintenance of machinery, while non-use values refer to any other economic value FAW may involve that causes the farmer to provide FAW-related efforts beyond the levels required to ensure the use values. Non-use values related to FAW may be derived from the satisfaction and comfort farmers gain by knowing that their production animals, as sentient beings, do not suffer in the production processes (McInerney 2004; Lagerkvist *et al* 2011), and from the fact that animal-friendly production may help facilitate longer business-to-customer relationships and establish legitimacy by building trust, reputation and recognition (Lagerkvist *et al* 2011). Use values of FAW may be recognised similarly by all farmers with similar production conditions (Lagerkvist *et al* 2011), but farmers are likely to differ in: i) the non-use values they recognise; and ii) their preferences for a given non-use value. This implies that the domains, or the coverage, of the FAW attitude construct are likely to differ between different types of farmers who recognise different types of non-use values, a factor which has to be taken into consideration when measuring attitudes.

Defining attitudes

Attitudes are defined as affective responses to objects, ie the immediate reactions of liking, disliking or indifference to objects (Pretty *et al* 1997; Ajzen & Fishbein 2000; Kahneman & Sugden 2005; van Overwalle & Siebler 2005). These evaluations are based on cognitive, affective or behavioural routes or any combination of these (eg Fazio & Olson 2003). A farmer's positive attitude towards FAW may thus express itself in a belief (eg farm animals should have a good life), a feeling (eg pride that animals are well-kept) and/or a behaviour (eg giving animals as long a grazing period as possible).

People may have attitudes about all types of objects, including objects about which they do not have to make decisions (Kahneman & Sugden 2005). Attitudes are driven by the references people make to the world and are therefore influenced by "framing effects and context effects" (Kahneman & Sugden 2005; p 164). Thus, attitudes can be expected to originate from a bounded rational thinking process, where traces of bounded rationality are summarised into frames, reference points and heuristics (Kahneman 2003). Furthermore, attitudes are themselves instrumental to the values individuals hold (Grube *et al* 1994). In the case of farmers' attitudes to FAW, these values are primarily the use and non-use values farmers associate with FAW.

Attitudes may be specific to domains, an idea put forward by Weber *et al* (2002) in the context of attitudes to risk, where they argue that risk attitude may differ depending on the domain in which the attitude is being evaluated. From an animal welfare point of view this means that farmers' attitudes to FAW at a more general level may be viewed as a function of their attitudes to more specific parts of FAW (specific attitudes).

Explicit measurement of attitudes: reflective or formative measurement models?

Since they exist in peoples' minds, attitudes are viewed as latent constructs. Psychometric methodology generally captures latent constructs via self-reported scales where subjects rate the target of evaluation on some bipolar scale such as agree/disagree, or in terms of importance. Such responses are then taken as indicators of the construct (DeVellis 2003; Podsakoff *et al* 2003; Hair *et al* 2010).

In the task of explicit measurement of attitudes, an important decision concerns that of the causality between the latent construct and its measurement indicators (Rositter 2002; Jarvis *et al* 2003; Podsakoff *et al* 2003). This guides the decision on which measurement model and scale development technique to use in order to capture the attitude construct. The question boils down to whether a reflective or formative measurement model should be used. Basically, this relates to the causality between the latent construct and its measurement indicators. A reflective measurement model assumes causality going from the latent construct to the measurement indicators, and hence the latent construct is reflected through the measurement indicators. This means that the latent construct causes the observed levels of the measurement indicators. A formative measurement model, on the other hand, assumes causality going from the measurement indicators to the latent constructs, implying that the construct is defined by its indicators. This means that the observed levels of the measurement indicators together constitute the latent construct.

Existing studies of farmers' FAW attitudes are generally unclear about the rationale for their choice of a formative or reflective measurement model. The discussion would benefit in terms of clarity if an explicit set of criteria were available for deciding on the measurement model used. Jarvis *et al* (2003) provided such a set of criteria and advised researchers not only to take into consideration the causality between constructs and indicators, but also to be guided by the interchangeability between indicators, covariation between indicators and whether or not indicators originate from the same nomological network. These decision criteria were adapted and evaluated here for the case of farmers' attitudes to animal welfare, considered in terms of the specific attitudes to each domain of the FAW attitude. The theoretical understanding adopted for the attitude construct was that the specific attitude construct is manifested through the indicators, ie that causality goes from the construct to the indicators and the attitude construct shows itself through the indicators. This implies that the construct is independent of the indicators and that the attitudinal construct is what it is, irrespective of the indicators used to measure it, or whether one or more indicators are dropped. However, a change in the attitude construct would cause changes in the respondent's answers to the indicators. Furthermore, our theoretical understanding of the attitude construct was that a set of indicators that successfully captures the construct share antecedents and consequences and, thus, have a common theme, and can be expected to be correlated to each other.

Table 1 Decision criteria used for the measurement model (adapted from Jarvis *et al* 2003) and evaluation with respect to farmers' explicit attitudes to animal welfare.

Decision criterion adapted from Jarvis <i>et al</i> (2003)	Our evaluation with respect to attitudes to farmers' specific attitudes to farm animal welfare	Implications for measurement model (based on Jarvis <i>et al</i> 2003)
1. Based on the theoretical understanding of the latent construct, is direction of causality from the latent construct to the indicators or the other way round? Is the construct manifested through the indicators, or are indicators defining the construct?	The attitude construct is manifested through the indicators	Reflective model
2. If indicators were changed, would the construct also change?	No	Reflective model
3. Would a change in the construct change the indicators?	Yes: if the attitude grew stronger, the indicators would change. This would show itself as, eg other answers to indicators	Reflective model
4. Would one expect indicators to have similar content? Is it plausible to assume they have a common theme?	Yes	Reflective model
5. If one indicator were dropped, would the theoretical understanding of the construct change?	No	Reflective model
6. Would a change in one indicator lead to a change in the other indicators too? Are they expected to covary?	Yes	Reflective model
7. What is the nomological net of the indicators? Can they be assumed to share antecedents and consequences?	Yes	Reflective model

A summary of the evaluation is shown in Table 1. Based on this evaluation, it was concluded that explicit measurement of farmers' FAW attitudes should be based on a reflective measurement model.

Summary of conceptual framework: a hypothetical model of farmers' FAW attitudes and attitudes' relationship to farmers' behaviours

Combining the theoretical views presented above allowed us to formulate a hypothetical model in which farmers' FAW attitudes are conceptualised as an outcome of use and non-use values (McInerney 2004) and as one type of antecedents of farmers' behaviour in relation to animal welfare. The model is shown in Figure 1. Farmers' latent attitude construct to FAW is viewed as an antecedent of their behaviour with respect to FAW. The attitude construct is considered to cover a number of domains, each of which is associated with a corresponding specific attitude construct, and to add up to a more general FAW attitude construct. Each specific attitude construct is considered to have a reflective relationship to its indicators. The use and non-use values farmers associate with FAW are viewed as antecedents of the attitude constructs and these are formulated in a context of culture, ethics and illusions and in some cases pure misunderstandings. At the level of the individual farmer, the recognition of use and non-use values depends on his/her perceptions of, and preferences for, non-use values.

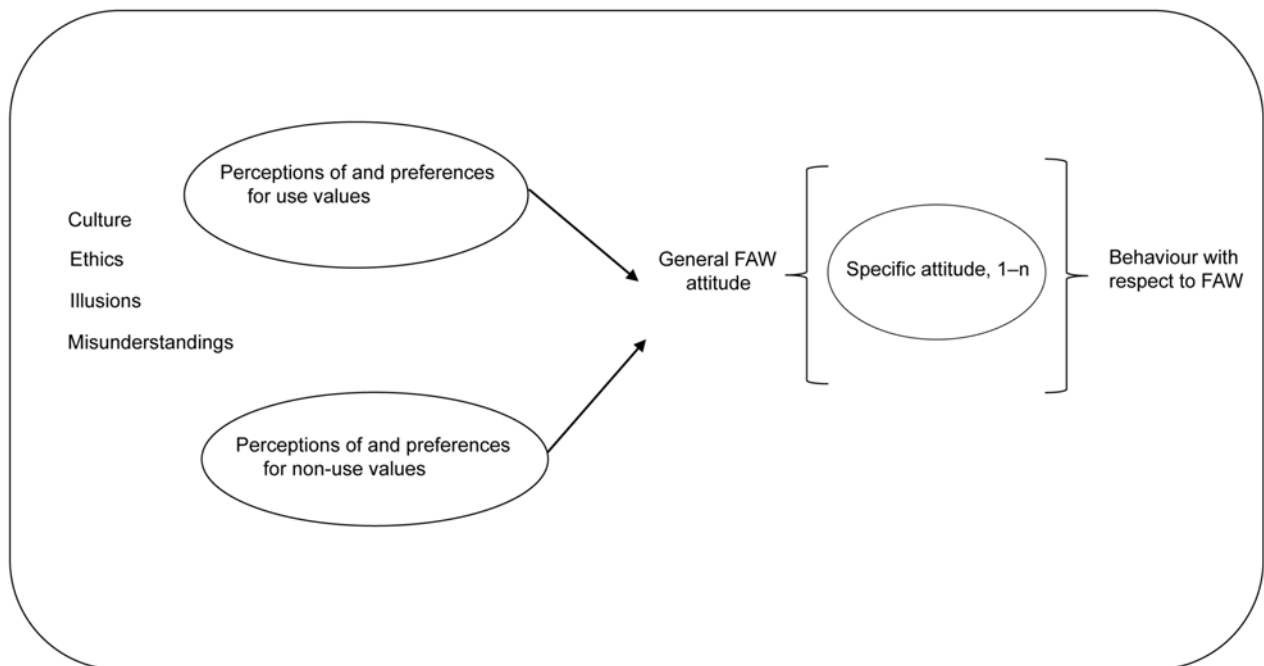
A psychometric framework for measuring explicit attitudes

In the model developed above, farmers' specific FAW attitudes are considered as having a reflective relationship between the construct and its indicators. Explicit measurement of attitudes involves the use of indicators that are collected from empirical observations, for instance by asking a respondent to answer a set of questions in a questionnaire and using the answers as measurement indicators. It is often necessary to use more than one indicator of a latent construct to comprehensively capture the construct. An important component in the measurement of a latent construct is evaluation of how well the indicators succeed in capturing the latent construct. In the following section we briefly outline how latent attitudinal constructs can be measured and evaluated once indicators have been collected.

Measurement model: exploratory or confirmatory

The explicit measurement of attitudes, assuming a reflective relationship between the attitudinal construct and its indicators, leaves the researcher with a choice between two measurement models: exploratory or confirmatory. These differ in whether or not the researcher can specify beforehand the dimensionality of the attitudinal construct (if there is a need to specify sub-constructs of general attitude construct) and in the measurement indicators associated with a particular latent construct. If no prior theory

Figure 1



Hypothetical model of farmers' attitudes to FAW.

exists to guide the researcher about the appearance of the attitude construct, an exploratory measurement model would be appropriate (Podsakoff *et al* 2003). This is normally the case in situations where there is an underdeveloped or no prior measurement scale. The exploratory factor analysis assigns measurement indicators to factors, ie the latent constructs. Each item is associated with each factor, but to a varying degree. Items associated strongly with the same factor, ie items loading highly on one factor, are evaluated as measuring that factor.

If prior theory exists to guide the researcher about the set-up of the measurement model or if the researcher would like to test a model obtained from an earlier analysis based on an exploratory factor analysis, the confirmatory measurement model would be the appropriate choice (Podsakoff *et al* 2003; Hair *et al* 2010). This model is based on confirmatory factor analysis and requires the researcher to specify beforehand the measurement indicators that should be used to measure a particular latent construct, and the analysis evaluates the statistical properties of the measurement model. With this property, confirmatory factor analysis allows the researcher to test theory in a way that exploratory factor analysis does not.

Evaluating the measurement of the latent construct: construct reliability and validity

Valid measurement of latent constructs requires reliability of the measurement model. Reliability refers to the degree

to which measurement indicators are related and measure the same thing (Hair *et al* 2010). High reliability is associated with a low level of measurement error in the latent construct and can be evaluated with analyses of the item-to-total correlations, inter-item-correlations, Cronbach's alpha, average variance extracted and composite reliability. The latter measures are only possible within the confirmatory factor analysis framework.

Furthermore, valid measurement of latent constructs requires validity of the measurement model. Hair *et al* (2010) describe validity in terms of content, convergent, discriminant and nomological validity. Content validity refers to the possibility to interpret the measurement model from a theoretical and practical point of view. Convergent validity refers to whether or not the measure of the latent construct is correlated with another, adjacent construct. Discriminant validity implies that the measurement items succeed in capturing a latent construct that is not highly correlated with other latent constructs from which it is theoretically distinct. Nomological validity, finally, refers to the extent to which the measurement scale can assess relationships that are known to exist from theory or other research.

Needless to say, proper assessment of construct validity would require repeated studies where the measurement scale is repeatedly evaluated and subsequently refined. However, content validity should be ensured in introductory exploratory analyses too.

Implications of misspecification of measurement model — an empirical example

In order to demonstrate the implications of potential misspecifications of the attitude construct in one empirical setting, we compared the domain of the FAW attitude construct suggested by a reflective measurement model with that suggested by a formative measurement model. In both cases the explorative approach was used. All statistical analyses were conducted in Stata 10.1. A dataset collected with the aim of developing a measurement scale to capture farmers' attitudes to animal welfare and health based on a psychometric framework, where farmers' management practices with respect to animal welfare and health were considered indicators of their latent FAW attitude and hence used as measurement indicators, was made available and used in this study. In contrast to Kauppinen *et al* (2010), the measurement indicators we used are considered to capture farmers' attitudes to FAW itself, rather than to particular behaviours and actions leading to improvements in FAW. Full details of the dataset used, including considerations when developing the measurement indicators, are provided by Hansson and Lagerkvist (2012). In total, the dataset contained nine measurement indicators to capture farmers' attitudes to animal welfare and health. Table 2 shows the measurement indicators and summary statistics.

Prior to applying common factor analysis (reflective measurement model) and principal component factor analysis (formative measurement model) to the nine measurement statements, the Kaiser-Miller overall measure of sampling adequacy (KMO) of the matrix and the KMO of each individual measurement indicator were assessed to evaluate the factorability of the matrix. This caused one measurement variable to be removed (statement number 5 in Table 2). While the KMO considers the covariation between measurement indicators and is hence only necessary for the analysis based on the reflective measurement model, this measurement indicator was also removed from the analysis based on the formative measurement model in order to facilitate comparisons of the results obtained. In line with recommendations by Hair *et al* (2010), factor loadings of 0.5 and above were considered significant, given the size of the dataset. In the analysis based on the reflective measurement model, measurement items with insignificant loadings appeared. These were removed, one at a time, starting with that with the lowest communality, until only items with significant loadings remained. The final factor solutions were rotated using the oblique rotation technique.

Reflective versus formative measurement models for eliciting farmers' attitudes to FAW

Common factor analysis and principal component factor analysis were applied to the measurement indicators to evaluate the latent FAW attitude constructs underlying farmers' management practices with respect to animal welfare and health. The results are shown in Table 3. The factor solution based on the reflective measurement model suggested that there was only one factor, and hence the FAW attitude construct was evaluated as unidimensional

and the general FAW attitude as consisting of one specific attitude. This factor comprised indicators related to the health and comfort of the animals, as we reported in a previous study (Hansson & Lagerkvist 2012). This factor solution hence suggested that farmers think about FAW in terms of the comfort and health of their animals.

In contrast, the factor solution based on the formative measurement model suggested a three-dimensional FAW attitude construct. The first factor was identical to the factor obtained with the reflective measurement model, although the loadings of individual items on the underlying attitude construct were stronger. The second factor comprised indicators about use of veterinary services, free-range opportunities and preparedness for power failures. This factor was therefore interpreted as being about preparedness to handle health and management issues in the herd and to allow animals to move around freely. The third factor comprised indicators related to the production system, including the acclimatisation of replacement stock to the current production system and use of barbed wire.

For the reasons stated above, we considered the measurement model based on common factor analysis to be more correct from a theoretical point of view and hence with this factor solution more correctly representing the underlying attitude construct. The results clearly show the importance of model specification. A solution based on the formative measurement model would lead to farmers' FAW attitude being conceptualised as a three-dimensional construct, covering domains that are not supported by the reflective measurement model. Hence, the formative measurement model would lead to farmers' FAW attitude construct being conceptualised as having a broader coverage and being potentially related to a different set of behaviours than suggested by the reflective measurement model. It should be noted, however, that the sample size in the current study must be considered small and that the differences between factor solutions might have been smaller if a larger data set had been available. However, as long as the two measurement models produce results that are not identical, a conflicting understanding is gained of the FAW attitude construct.

Towards a better understanding of farmers' attitudes to animal welfare: preliminary domain of the FAW attitude construct

In this section, we review and synthesise the literature related to farmers' FAW attitudes in order to set the way forward for research related to this attitudinal construct by formulating a preliminary domain of the construct that can be tested in future research. The existing literature related to FAW attitude constructs is inductive in the sense that empirical observations are used to formulate conclusions about the construct. Research related to the FAW attitude construct would therefore benefit from an approach where insights from these studies are further tested. The synthesis provided here can also be used in future research aimed at developing and testing indicators for use in explicit measurement of the attitude construct.

Table 2 Measurement scale items and summary statistics (n = 108).

Statement about livestock management practices	Mean (\pm SD)	Min-max values	Number of missing observations
1. My replacement stock is not carefully acclimatised to the production system in which they are to be used	1.87 (\pm 1.036)	1-5	19
2. I never call in a veterinarian to my livestock production	2.90 (\pm 1.280)	1-5	5
3. My animals are to a small extent kept in a free-range system	2.16 (\pm 1.331)	1-5	8
4. I am not well prepared to handle power failures in my livestock production, eg no back-up system	2.81 (\pm 1.612)	1-5	8
5. The housing system used for my animals does not allow natural behaviour	1.75 (\pm 0.841)	1-4	6
6. My animals have health problems regularly	1.35 (\pm 0.606)	1-3	5
7. I do not have a low mortality level in my animal production	1.60 (\pm 0.911)	1-5	5
8. My animals never have plenty of bedding	1.53 (\pm 0.836)	1-5	8
9. I use barbed wire to a large extent	2.70 (\pm 1.403)	1-5	9

Underlying scale: 1 = I do not agree at all and 5 = I agree completely. This table was originally published in a study by Hansson and Lagerkvist (2012) and is reproduced here with the kind permission of the Emerald Group Publishing.

Table 3 Measures of farmers' FAW attitudes elicited with reflective and formative measurement models.

Statement about management practices	Factor solution based on a reflective measurement model		Factor solution based on a formative measurement model		
	Factor 1		Factor 1	Factor 2	Factor 3
1. My replacement stock is not carefully acclimatised to the production system in which they are to be used					-0.602
2. I never call in a veterinarian to my livestock production				0.500	
3. My animals are to a small extent kept in a free-range system				0.737	
4. I am not well prepared to handle power failures in my livestock production, eg no back-up system				-0.728	
5. The housing system used for my animals does not allow natural behaviour					
6. My animals have health problems regularly	0.620		0.755		
7. I do not have a low mortality level in my animal production	0.593		0.744		
8. My animals never have plenty of bedding	0.530		0.762		
9. I use barbed wire to a large extent					0.758

Statement 5 was removed from the analysis on the grounds that its KMO measure was too low. Only significant loadings are shown. Proportions of total variance explained by the factors derived from the formative measurement model are 24.02, 20.06 and 14.45%, respectively. Proportion of variance explained by the factor derived from the reflective measurement variable could not be computed because the matrix is non-positive definite, which is generally the case in principal axis factor analysis. The principal axis factor analysis is based on the common variance of the data.

A review of the literature suggests there is reason to group farmers before assessing their FAW attitudes. First, according to the literature, there are two different groups of farmers depending on the reasons they perceive for animal welfare: i) those who view animal welfare as a means to achieve economic results; and ii) those who view animal welfare as also a way to satisfy moral and ethical consider-

ations in their production (Hubbard *et al* 2006, 2007; Bock & van Huik 2007). The literature also suggests that these two groups can be distinguished into conventional and organic producers (Hubbard *et al* 2006, 2007; Kling-Eveillard *et al* 2007; van Huik & Bock 2007). Furthermore, farmers may be grouped according to the category of animals they keep. In particular, it has been found that

longer animal-human relationships tend to improve the welfare of the animals (Bock *et al* 2007).

As far as the division of farmers into conventional and organic is concerned, the former are reported to perceive animal welfare as being about animal health and the fundamental physiological needs animals may have (Bock & van Huik 2007). This resembles the domain of the attitude construct obtained by Hansson and Lagerkvist (2012) and reproduced in the present study. The organic group is reported to perceive animal welfare as being about the natural behaviour of the animals (Bock & van Huik 2007). Through qualitative interviews, Kauppinen *et al* (2010) found that farmers also think about animal welfare in terms of the living environment of the animals, their healthcare, humane treatment of the animals, and farmers' own well-being and motivation at work. The latter finding is especially interesting, since it suggests that FAW is related to farmers' feelings about themselves and their job motivation. Furthermore, the interviews reported by Kauppinen *et al* (2010) emphasised that farmers think about animal welfare in terms of animal health and comfort. That study also elicited farmers' FAW attitudes quantitatively and found a two-dimensional construct that was perceived as being about reward-seeking (both monetary and mental rewards) and empathy. Austin *et al* (2005) also elicited farmers' animal welfare attitudes (not restricted to FAW) quantitatively and found a five-dimensional construct that they evaluated as being about farmers' knowledge and information on FAW, empathy, dislike of killing pests, relations between animal welfare and how the animal is functioning, and profit motivation. Both those studies were based on formative measurement models, and it is possible that findings would have differed had they been based on reflective measurement models.

In sum, our reading of the literature suggests that farmers' FAW attitude constructs cover the domains of: animal health, psychological needs of the animals, natural behaviour of the animals, living environment of the animals, humane and ethical treatment of the animals, profitability of the animals, and the farmer's own well-being and knowledge. The attitudinal constructs may thus cover domains relating to animal well-being and needs and also domains relating to farmer well-being and needs, suggesting that farmers view FAW as related to their own well-being. This is in line with the view that animal welfare is interconnected with human welfare. Previous studies on attitude constructs adjacent to farmers' FAW attitudinal constructs, such as attitudes to animals, support the domains found in the literature related to farmers' FAW attitudinal constructs. For instance, Serpell (2004) concluded that the construct was two-dimensional and consisted of utility and affect considerations, both of which can be traced in the literature cited above. Hanna *et al* (2009) studied farmers' attitudes to cows and found the attitude construct to be four-dimensional, with these dimensions given the following labels: empathy (for the animal); negative beliefs (about the cows); job satisfaction (human-animal relationships); and patience (beliefs about the importance of patience when dealing with animals), again supporting the domains suggested above. At this stage, however, the list of domains above should not be viewed as exhaustive, as there may also be other domains of attitude constructs not yet discussed in the scientific literature.

Animal welfare implications and conclusion

Farmers make the actual decisions about what FAW efforts to provide, so they play a critical role in determining the living conditions of production animals. In this context, the attitude construct, which is one antecedent of people's behaviour, seems particularly important. The hypothetical model outlined in this paper and the insights it provides on how to measure attitudes and work related to the measurement of farmers' FAW attitudes have important implications for animal welfare. Understanding the FAW attitudes of farmers, who make the real decisions about the living conditions of production animals, is an important step in understanding the determinants of FAW.

In this study, we placed farmers' attitudes to FAW in a hypothetical model in which they were viewed as the outcome of use and non-use values (McInerney 2004) and as one type of antecedent of farmers' behaviour with respect to FAW. We also outlined a psychometric framework for measuring these attitudes. We suggest that farmers' specific attitudes to FAW be measured with reflective measurement models, acknowledging a relationship between the construct and the measurement indicators whereby the construct causes its measurement indicators. This is in accordance with how attitude constructs are generally measured (eg Pennings & Leuthold 2000; Pennings & Smidts 2000; Pennings & Garcia 2001; Weber *et al* 2002; Hansson & Lagerkvist 2012).

Previous studies have been based on both formative and reflective measurement models, but we argue that formative measurement models are theoretically misspecified. In this study we evaluated the implications of such model misspecification in an empirical example and found that it may have seriously influenced our conceptualisation of the FAW attitude construct. This implies that specification of measurement model is a question that researchers need to take seriously and that misspecification may produce results that are misleading in understanding farmers' attitudes to FAW.

Based on our reading of the literature related to farmers' FAW attitudes, we suggest that farmers' attitudes to FAW cover the following preliminary domains: animal health, physiological needs of the animals, natural behaviour of the animals, living environment of the animals, humane and ethical treatment of the animals, profitability of the animals and the farmer's own well-being and knowledge. Farmers may differ in their attitudes to FAW depending on whether they have organic production and what category of farm animals they keep. The existence of these domains needs to be empirically validated in future research. We suggest that this be done in the type of psychometric framework outlined in this article, but this approach first requires the development of measurement scales to capture each domain. Future research should also evaluate whether there are also other domains and whether and how the existence of these domains differs between farmers with different production types and animals. Furthermore, future research should evaluate whether the same types of domains can be used to capture the FAW attitudes of stakeholders other than farmers, such as consumers, veterinarians and pressure

groups, and whether and how farmers and these other stakeholders differ in the strengths of their FAW attitudes.

In the model developed here, use and non-use values are viewed as antecedents of farmers' FAW attitudes. Future research needs to identify in particular what these non-use values represent to farmers and assess their impact in comparison with the use values in farmers' decision-making with respect to FAW. Future research into farmers' efforts related to FAW should also examine how decisions that influence FAW are interrelated with other decisions on the farm and how the FAW attitude construct is correlated with other attitudes.

Acknowledgements

We are grateful to the three anonymous reviewers and the Section Editor for helpful and constructive comments. This study was funded by The Swedish Research Council Formas, grant no: 220-2011-254, which is gratefully acknowledged.

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